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(54) Microwave noise measuring apparatus

(57) Apparatus for measuring the phase noise content of a microwave signal source (10) includes e microwave cavity (22) resonant et a fixed frequency, signal generating means (23) operable to generate a frequency representing the difference between the source frequency and that of the resonant cavity, and mixing means (20) for combining the outputs of the source end the signel generating means. The output from the resonant cavity 22 is applied to a phase detector (15) together with e portion of the output of the mixing means (20) in phase quadrature therewith (16) and the output of the phase detector (15) represents the phase noise content of the output of the microwave source (10). The signal generating means (23) includes e voltage-controlled oscillator the frequency of which is controlled by an output from the phase detector means (15) so as to maintain the output of the mixing means (20) at the resonant frequency of the microwave cavity (22).

Fig.2.

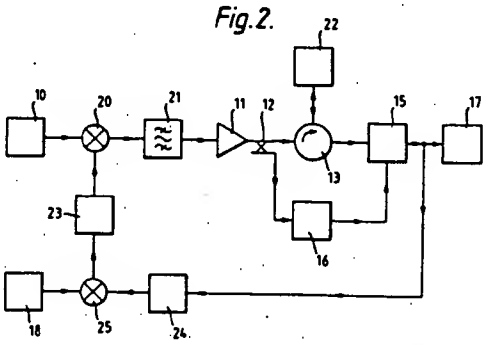

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Fig.1.

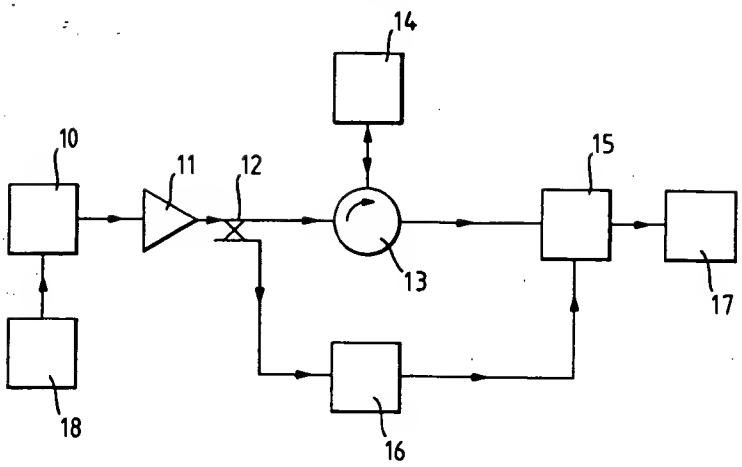


Fig.2.

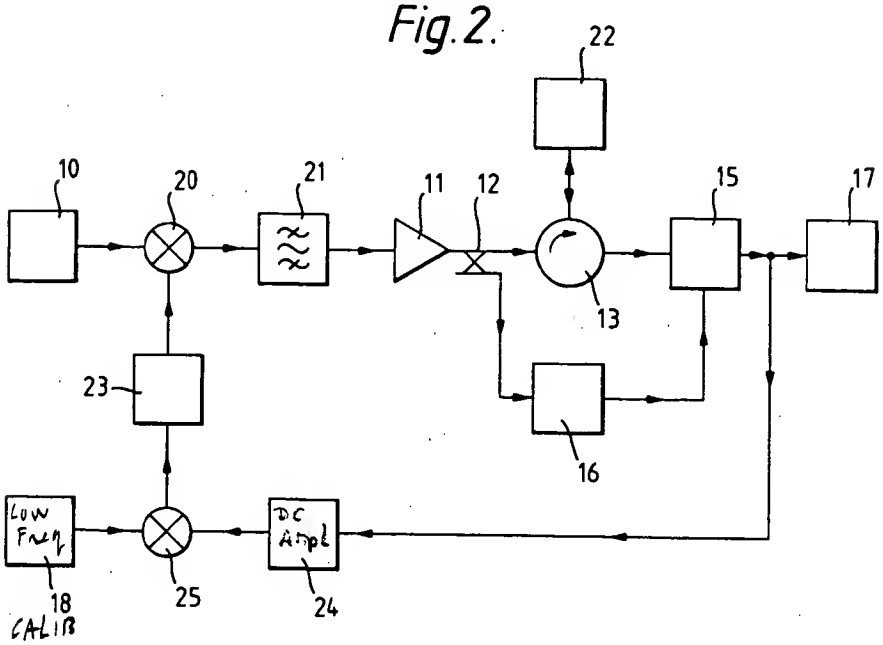
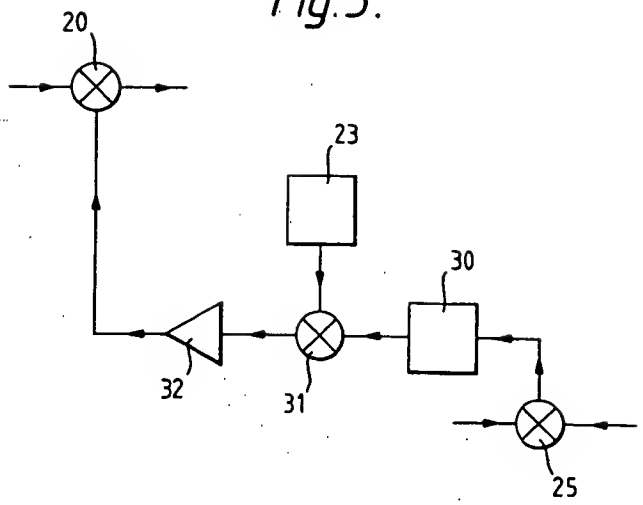


Fig.3.



SPECIFICATION

Microwave noise measuring apparatus

This invention relates to microwave noisa maasuring apparatus intendad particularly for tha maasurement of tha phase noise contant of a microwava signal source.

All microwave signal sources ganerate unwanted phasa noisa, that is noise in the form of random frequency variations about tha source output frequency. Whilst the magnitude of the phasa noise content of a signal may be small it may become significant, for example in doppler fraquency radar systams. This is because tha radar return applied to a dopplar radar raceiver may ba vary small and is in tha form of a small changa in frequency from that of tha transmitted radar signal. It will be appraciatad therefore that phasa noise could lead to erroneous interpretations of dopplar signals or mask them altogether.

In order to control or reduce the phase noise content of tha output of a microwava signal source it is first necassary to ba able to maasura tha phasa noisa. Several techniques are known for this, but these hava disadvantagas which affect their use and accuracy. Tha techniques described relata to single-fraquency microwave sourcas of tha type which may be tunable over only a few tens of MHz.

One techniqua involves cross-correlation between two microwave sources, ona being tha source undar test and the other being a raferanca. Tha main problem with this technique is tha difficulty of obtaining a referanca sourca which is of significantly battar performance than tha source under test. As a result a reference source may not be available, and this technique is tharafore of no use.

Othar techniquas exist which use only the source undar test. One makes use of a delay lina to which the output of the sourca is applied and a phase detactor comparing tha output of the delay lina with the source output 90° out of phase with it. The delay line transforms frequency fluctuations into phase fluctuations and the phasa datector converts these into voltage fluctuations at its output. Unfortunately such a system has low sensitivity due to the limited amount of input power which can be appliad to the system.

A second technique which avoids this problem uses a tunable cavity resonator to provide a dalay in place of the delay line. Tha cavity is tunad to tha frequency of tha signal sourca and has the effect of suppressing tha source frequency whilst leaving tha noise frequency signals. This anables graatar power to ba appliad to the measuring systam, thus increasing the sensitivity. Tha problems which arise from the usa of this technique are associatad with the usa of a tunable rasonant cavity. Firstly the cavity has to be returnad for each source frequancy, and this takes tima. In addition tha rasonant fraquancy of tha cavity may wall be sansitiva to mechanical vibration. Finally, all othar componants in the maasuring system must have wide bandwidths to covar tha tuning range which tha system may have to covar.

It is an object of the present invention to provida apparatus for measuring the phasa noise content of the output of a microwava signal source which raquires only a single microwave sourca and which doas not suffar from the problems sat out abova.

According to the presant invention thare is providad apparatus for maasuring the phase noise contant of the output of a microwave signal source, which includes a microwave cavity resonant at a fixed frequancy differing from that of the source by batwaan 1% and 10% of tha cavity resonant frequency, signal generating means oparabla to genarata a signal representing the difference between the fraquency generated by the microwave signal source and tha resonant frequency of tha cavity, mixing means operabla to combine the outputs of the microwave signal sourca and of the signal generating means to provida a signal having a frequency equal to tha resonant fraquancy of the cavity for application thereto, and phasa detector maans responsive to an output from the cavity and to an output from the mixing maans in phasa quadrature tharewith to provide a signal representing the phase noise content of the output of the microwave signal sourca.

Tha invention will now ba described with reference to the accompanying drawings, in which:–

Figure 1 shows a block diagram of known apparatus using a tunable resonant cavity;

Figure 2 is a block diagram of a first ambodiment of the invention; and

Figure 3 shows a modification to tha apparatus of Fig. 2.

Referring now to Fig. 1 a known phase noisa measuring systam includas the source under test 10 which applias a signal by way of a low noisa amplifiar 11, a 10dB coupler 12 and a circulator 13 to a tunable resonant cavity 14. An output from the cavity 14 passes via tha circulator 13 to a phase datector 15. Tha signal applied to the 10dB couplar 12 is also appliad by way of a phase shifter 16 to the phasa detector 15, tha phasa shifter baing arrangad so that its output is 90° out of phasa with the output of the rasonant cavity. The output of the phasa datector 15 is tha output of tha phase noise measuring systam and may, for axampla, be applied to a spactrum analyser 17. Tha analyser is particularly useful if the sourca under tast is fraquency modulated by a low fraquancy oscillator 18.

In use, the resonant cavity 14 has to be tuned to the frequency of the source under test. Tha affact of tha tuned cavity 14, so far as signals within the cavity bandwidth are

CLAIMS

1. Apparatus for measuring the phase noise content of the output of e microweve signal source, which includes e microwave cavity resonant at a fixed frequency differing from that of the source by between 1% end 10% of the cavity resonant frequency, signal generating meens operable to generate e signal representing the difference between the frequency generated by the microwave signal source and the resonant frequency of the cavity, mixing means operable to combine the outputs of the microwave signal source and of the signal generating means to provide e signal having e frequency equal to the resonant frequency of the cavity for application thereto, end phase detector meens responsive to en output from the cavity end to en output from the mixing meens in phase quadrature therewith to provide e signal representing the phase noise content of the output of the microwave signal source.

2. Apparatus as claimed in Claim 1 in which the signal generating means comprise a variable-frequency oscillator the frequency of which is controlled by an output from the phase detector means so as to maintain the output of the mixing means at the resonant frequency of the microwave cavity.

3. Apparatus as claimed in Claim 1 in which the signal generating means comprise a fixed frequency oscillator, e voltage-controlled oscillator and second mixing means for combining the outputs of the fixed frequency and voltage controlled oscillation of the voltage-controlled oscillator being controlled by an output from the phase detector means so as to maintain the output of the mixing means at the resonant frequency of the microwave cavity.

4. Apparatus as claimed in either of Claims 2 or 3 in which the output of the phase detecting means is applied to the voltage-controlled oscillator by way of further mixing means to which may be applied the output of a low frequency calibration oscillator.

5. Apparatus as claimed in any one of the preceding claims which includes a band-pass filter connected between the mixing means and the microwave cavity and phase-shifting means.

6. Apparatus for measuring the phase noise content of the output of a microwave signal source substantially as herein described with reference to Figs. 2 and 3 of the accompanying drawings.

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